SOME CHARACTERS OF THE SOUTHERN TUCKAHOE

JOHN A. ELLIOTT

(WITH PLATES 17 AND 18)

The literature on *Pachyma cocos* is so abundant and covers so long a period that even a complete bibliography would take considerable space. Regardless of this fact, the fungus still remains a mycological mystery about which even the smallest additional information is likely to be of interest.

Although work had previously been done (5) toward establishing the purely fungoid nature of the tuckahoe, Prillieux (6) apparently deserves the credit of having first definitely stated that it was made up entirely of fungous elements. Fischer (4) carried the work considerably further in showing rather conclusively how the different types of tissues arose. The relation between the tuckahoe and the roots to which it was usually found attached has been variously explained. The early observers considered it entirely an outgrowth of the roots on which it was found. Berkeley (1) thought it an abnormal development of the root, induced, perhaps, by the action of a fungus. Fischer's conclusion that the tuckahoe is parasitic (4) in its nature has apparently not been questioned; but while there is no doubt that the fungus is destructive to woody tissues, from the information collected by Gore (5) it would seem that the fungus is a saprophyte, although it may be a facultative parasite as well.

The chemical nature of the tuckahoe was the first of its characters satisfactorily established. Torrey (7) reported the first analysis of the tuckahoe in 1821, stating that it was made up largely of a vegetable principle, which he called "sclerotin," and following Braconnet's (3) work on pectic acid, Torrey (8) identified his "sclerotin" as the pectic acid of Braconnet.

The generic relations of the tuckahoe have always been a matter of interest and speculation. There is little object in going into

history of the various guesses by those who had little or no knowledge of mycology. Gore's discussion (5) includes a report by W. H. Seaman on the botanical nature of tuckahoe, in which Seaman states that he would expect spores to develop from the dark mycelium directly beneath the cortical layer. Nothing, however, is suggested as to the possible generic relation of the fungus. Fischer (3), while he does not go into an exhaustive study of the possible generic relations, suggests, from analogy, that the tuckahoe probably gives rise to a polypore. Bommer (2) took up the study at the point Fischer left off and, after a comparative study of many sclerotia-forming fungi, suggested that *Pachyma cocos* may either be sterile or may be connected with the genus *Lentinus*.

Observations I have made on the tuckahoe have revealed some additional characters which may throw some light on the generic position and the habits of the fungus. Three different specimens have been sent to the Arkansas laboratory. The first was a small specimen with a smooth coat and showing no apparent connection with any foreign object. The other specimens were quite large and, according to the workmen who had dug them, were attached to sumac roots. They were of the rough-coated type generally described (Pl. 17, f. 1). One had been cut off of what was apparently a disintegrating root, the other had a living root slightly attached to one side by an overgrowing rhizomorph. The specimens were cut in halves and tissues from various parts examined microscopically by Prof. H. R. Rosen and myself. Our observations at this time revealed one point that so far as I have been able to ascertain has not been reported previously—*i.e.*, that the finer fungous threads quite commonly show the typical, clamp connections found in basidiomycetes (Fig. 1).

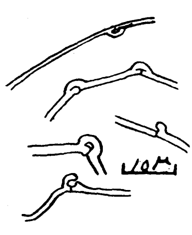

Fig. 1. Mycelium from *Pachyma cocos* showing clamp connections

With the purpose of inducing the sclerotium to produce a carpophore, one half of the larger specimen was placed on a glass surface under a bell jar and kept in the laboratory throughout the summer. No attention was given it beyond keeping it moist. The cut surface, which had been placed next to the glass, promptly produced a dark-brown, felty cortex which, as it aged, became more and more like the coat which covered the original surface (Pl. 17, f. 2, and pl. 18, f. 3). After this coat was formed, no change having been noted for several weeks, the sclerotium was placed in moist sand between some cotton plants on a greenhouse bench. It was again placed with the newly cut surface down. The only attention paid to the fungus during the winter was to uncover occasionally the upper half to discover any possible outgrowths. As in several months no change could be observed in the sclerotium aside from a slight yielding under pressure, it was dug out, upon which several interesting things were revealed. A rather large, black, root-like outgrowth had been put out from the lower surface of the sclerotium at the edge of the cut surface (Pl. 18, f. 4). This had spread out fan-wise as it reached the wood of the bench and spread over the surface of the wood for some distance. It seemed to be very securely attached to the pine-wood bench. Other strands had produced cylindrical sheaths covering two cotton roots which came in their way.

In detaching the fungus from the bench, the main rhizomorph was broken and several large drops of a milky fluid were exuded from the broken ends, principally from the one attached to the main sclerotium. This fluid was odorless and tasteless, as far as could be determined. One of the fungous sheaths surrounding the cotton roots was removed to observe, if possible, any effect on the root. Except for being a little brighter colored (supposedly because it was cleaner) than the parts of the root outside of the sheath, no effect on the root could be observed. The sclerotium was again placed in its position on the greenhouse bench, where, after several months, it was found that no further development had occurred, and that the rhizomorph had disintegrated (Pl. 18, f. 3). The sclerotium was again cut in two for examination. It had much the same appearance as when first found, except that it

was markedly less dense in structure, indicating a probable exhaustion of much of the stored food material. An attempt was made to culture the fungus from the interior of the mass by removing portions of the tissues aseptically and planting them on cornmeal agar. Plantings from the center of the mass failed to germinate, but a rapidly growing mycelium developed from sections cut from near the cortex. Cultures of this mycelium were transferred to flasks of cornmeal agar, where they quickly covered the surface of the agar with a dark-brown, thick, sterile, felty growth. It made no further development.

The exudation of milky juice from the broken rhizomorph suggested the presence of lactiferous ducts and glands in the sclerotium, and sections were accordingly cut from various parts of the structure, embedded in paraffin, sectioned, and stained for more detailed microscopic study of its morphology. In addition to the

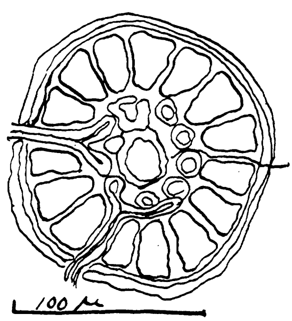

Fig. 2. Camera lucida drawing of a glandular body in *Pachyma cocos* showing entering ducts. This was one of the more regular forms.

variously shaped fungous elements which have been reported by Prillieux, Fischer, Bommer, and others, structures were found which would seem to be lactiferous ducts and glands. These were near the cortex in all cases observed. The ducts were thin-walled; large (10 μ) in comparison to the hyphal threads (2–4 μ) and usually ended in structures which were interpreted as glands (Fig. 2). With Flemming's triple stain, the fungus took a uniform light-blue stain throughout. However, scattered along the inside of the supposedly lactal glands and ducts were granules and droplets which took the safranin stain quite consistently. These drop-

lets were interpreted as being the remains of the lactic fluid which the glands had secreted.

The detailed structure of these glandular bodies is rather difficult to make out and is different in different specimens. Two constant features are the presence of an outer wall of several layers which have the appearance of the striations of a starch grain and the presence inside the body of a number of "ducts" which can be seen to penetrate the wall and apparently ramify throughout the interior. The structure within the striated walls is quite variable. While most of the large elements in the tuckahoe are homogenous bodies with no apparent striations whatever, an occasional body may be found in sectioned material which is markedly striated. The bodies interpreted as glands may be these large striated bodies partly dissolved by the action of the ducts entering them. They do, however, differ considerably from most of the larger elements of the tuckahoe, in their regularity of form. In looking over a slide they may be very readily located by following the path of the ducts, which invariably lead in their direction.

The presence of the milky juice and the lactiferous ducts and glandular bodies may be of some generic significance. However, it would seem essential, in a sclerotium of the size and nature of the southern tuckahoe, if the stored material is to be transported rapidly for the production of a fruiting body or any other purpose, that some system of glands and ducts be developed.

The behavior of the fungus in the greenhouse bench probably has no significance in determining its possible parasitism. The mycelium was apparently penetrating the pine boards in the bottom of the bench; also, it had overgrown two cotton plant roots without any apparent injury to them. Its failure to attack the cotton roots does not prove that the fungus can not attack living, pine roots, as has been so often affirmed. With suitable equipment, it should not be difficult to follow for a considerable period the development of the tuckahoe and its possible parasitic relation to various hosts. The idea, commonly prevalent among the earlier observers, that the whole sclerotium was covered with the bark of the root attacked, which idea led to the conclusion that the growth was an abnormally developed root, is easily understood. The cortex has much

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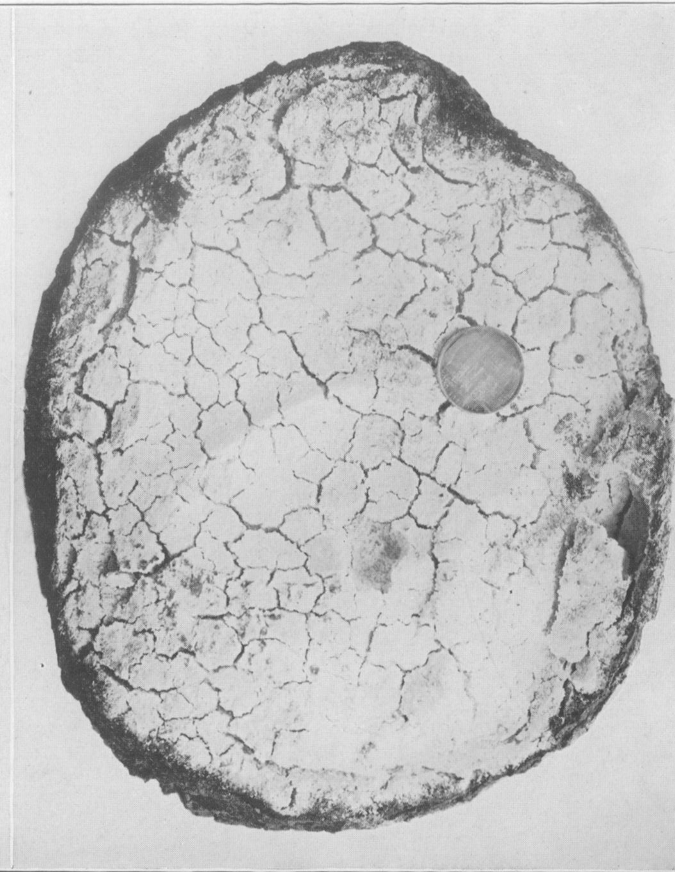
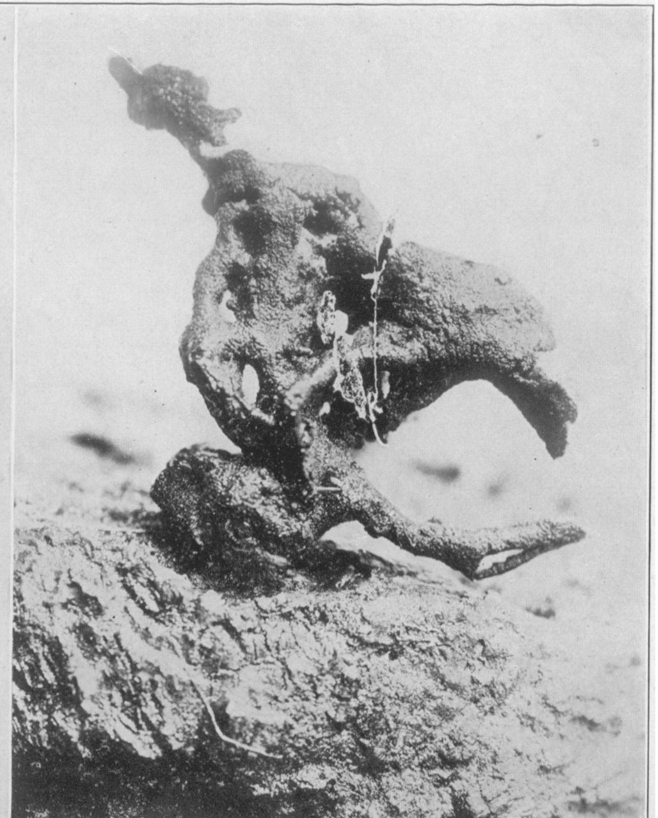


2. INTERIOR OF PACHYMA COCOS

3. SHOWING NEW CORTEX



4. SHOWING RHIZOMORPH

the appearance of the roughened bark of a large root, or, more nearly, of the bark of a tree trunk or branch, and for the same reason. A microscopic study of the cortex of the sclerotium may show little, if any, of the original wood or bark of the host, but the fungous cortex will be thicker and denser in some places than in others. The old cortex evidently stretches and cracks as the sclerotium enlarges, the newly developed cortex filling in the gaps between the older portions, making the surface rough and uneven.

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ARKANSAS EXPERIMENT STATION,
FAYETTEVILLE, ARKANSAS.

LITERATURE CITED

1. **Berkeley, M. J.** Indian Bread or Tuckahoe. The Gardener's Chronicle, 829. 1848.
2. **Bommer, C.** Sclerotia et Cordons Myceliens. 1894.
3. **Braconnet, H.** Recherches sur un nouvel acide universellement repandu dans tous les vegetaux. Annales de chimie et de physique. **25:** 358–373. 1824.
4. **Fischer, E.** Beitrage zur Kenntniss exotischer Pilze. Hedwigia. **2:** 61–126. 1891.
5. **Gore, J. H.** Tuckahoe, or Indian Bread. Smithsonian Report, 687–701. 1881.
6. **Prilleaux.** Le Pachyma Cocos en France. Bulletin de la societe botinique de France. **36:** 433. 1889.
7. **Torrey, J.** Analysis of the *Sclerotium giganteum* or Tuckahoe. The Medical Repository, new series. **6:** 37–44. 1821.
8. —— On the pectic acid of Braconnet, and its identity with Sclerotin, a peculiar principle existing in the Tuckahoe, or Indian Bread. (New York Medical and Physical Journal. **6:** 481–490. 1827.)

EXPLANATION OF PLATES 17 AND 18

Fig. 1. External view of *Pachyma cocos* Fries, showing roughened bark-like cortex.

Fig. 2. Cut surface of *Pachyma cocos* after drying about 24 hours. The homogenous character of the interior is evident. (The coin is a one-cent piece.)

Fig. 3. New cortex grown on cut surface of a tuckahoe (shown in Fig. 2), and remnant of rhizomorph shown in Fig. 4.

Fig. 4. Rhizomorph produced by a tuckahoe growing on a greenhouse bench. (This negative was scratched.)